Reconstructing the evolution of galaxies with cosmic time

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Reconstructing the evolution of galaxies with cosmic time

**Galaxy Spectroscopic Samples as time machines:**
- Lookback time studies;
- Archeological studies;
- Forecasts for future survey.

Key probes to investigate galaxy formation and evolution

Inferring the physical properties and star formation histories of galaxies through cosmic time
The role of the environment in galaxy evolution

Galaxies that live in dense environments (clusters, groups, filaments ...) are affected by physical processes that can alter their properties (quench star-formation, change shape etc).

Which is the epoch when the role of the environment was more effective?
Past, Present, public and future projects

- **zCOSMOS** (20k spectra @ z<1)
- **GMASS** (~200 spectra @ z<1 & z>2)
- **VIPERS** (100k spectra @ 0.5<z<1.2)
- **VUDS** (10k spectra @ z>2)
- **VANDELS** (2k spectra @ 1<z<4)
- **SDSS + BOSS** (high-R spectra @ z<0.5)
- **Lega-C** (spectra z~1)
- **MUSE + MANGA** (IFU)
- **WEAVE+STePs** (high-R spectra @ 0.3<z<0.8)
- **MOONS** (near-IR spectra 0.7<z<2)
- **Euclid** (Halpha emitters 0.9<z<2.3)
**Background:** The evolution of scaling relations is poorly constrained at $z>1$ (e.g. van de Sande+14; Belli+14). ETGs and massive SFGs may lie on the same FP (Bezanson+15).

**Aims:** Derive the evolution of scaling relations of dispersion-dominated galaxies (e.g. $\sigma_{\text{vel}}-M^*$, $M_{\text{dyn}}-M^*$, FP, mass-FP, size-mass, density-mass), constraints on $M/L$ and IMF, comparison of ETGs and SFGs, and with models of massive galaxy formation.

**How:** High $S/N$ and moderate resolution of VANDELS spectra to measure $\sigma_{\text{vel}}$ and estimate dynamical masses of individual and stacked spectra. HST imaging will be used for surface brightness profiles and structural parameters.

**Tools:** PPXF, STARLIGHT, GALFIT

People @ INAF-OABo: L. Pozzetti, M. Bolzonella, O. Cucciati
@ DIFA A. Cimatti, M. Moresco, M. Talia
How: spectral continuum decomposition, + absorption and emission lines from single or stacked high S/N spectra.

Aim: Derive physical properties (age, Z, dust, U, …) and SFHs as a function of cosmic time, galaxy type, environment

Surveys: VANDELS (1<z<4) + simulations WEAVE (0.3<z<0.8) + MOONS (z>0.8)

Tools: STARLIGHT, PPXF, CLOUDY

People involved @ INAF-OABo: L. Pozzetti, M. Bolzonella, O. Cucciati @ DIFA A. Cimatti, M. Moresco, M. Talia

VANDELS up to 300 ETGs @ 1.5<z<2.5

VANDELS up to 800 SFGs @ z>2.5

Citro+ 16 → Passive SFHs

10^{10.75} \text{ Msun}

10^{11.5} \text{ Msun}

Increasing mass

Spectral fitting decomposition

VANDELS up to 800 SFGs @ z>2.5

Citro+ 16

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Cosmology with passive galaxies in VANDELS

**Background:** $H(z)$ poor constraint at $z>1$

**Aims:** possibility of setting *cosmological constraints* from the spectroscopic evolution (studying absorption and continuum indices) of passive galaxies

**How:** using *D4000 and UV indices and breaks* as cosmic chronometers (Moresco +2012, Moresco 2015, Moresco+2016).

**Surveys & Tools:** VANDELS spectra, MCMC

- From ~30 to ~300 Massive ($>10^{10.5}$ Msun) Passive galaxies @ 1.5<$z<$2.5

People involved @ DIFA, M. Moresco, A. Cimatti @ INAF-OASBo: L. Pozzetti
Density field reconstruction and identification of proto-clusters in VANDELS (z>2)

**Background:** At z>2 structures are still in formation, and it is easier to catch environmental processes in the moment they are happening.

**Aims:** The aim of this project is to characterize environment and to perform a systematic search of candidate proto-clusters in **VANDELS**

**How:** Using photometric and spectroscopic redshifts to derive environment, even at z>2. The *Voronoi* tessellation is effective for structures in formation, which might have different shapes.

**Tools:** An IDL tool is currently available for density field derivation and detection of proto-cluster candidates

People involved @ INAF-OABo: O. Cucciati, M. Bolzonella, L. Pozzetti @ DIFA A. Cimatti
**Background:** The Hα emission is a tracer of star formation activity. The study of the Hα Luminosity Function (LF) allows us to derive the total Cosmic Star Formation rate Density at any epoch.

**Aims:** Study of the Hα LF in different environments at z>2, to verify the enhancement of SF activity in high density regions. This analysis will be also used for the forecasts for the Euclid surveys.

**How:** Use of catalogues of Hα emitters (e.g. HiZELS) + environment characterization.

**Tools:** Codes already available for the derive the environment and for the computation of the LF

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**Other projects based on environment in other surveys are also available**

People @ INAF-OABo: **Cucciati**, Pozzetti, Zucca @ DIFA Cimatti